PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Flux Coated Low Hydrogen Welding Electrodes

We, ENGLISH ELECTRIC-ARC WELDING COMPANY LIMITED, (formerly Arc Manufacturing Company Limited), a British Company, of Actarc Works, Nitshill, Glasgow, S.W.3. and EDWARD ROBERTS, a British Subject of English Electric-Arc Welding Company Limited, Actarc Works, Nitshill, Glasgow, S.W.3. do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention is for improvements in or relating to flux coated low hydrogen welding electrodes. The surface of a welding electrode is normally covered with a flux material in order to provide protection from atmospheric contamination and to produce slag which inhibits the formation of oxide on the weld.

Typical of the materials used in the coating of low hydrogen electrodes are limestone, fluorspar, ferro-manganese, iron powder, rutile, zircon and clays, together with a binding agent. Electrodes so coated may be employed in the welding of mild steel, high tensile steel, chrome molybdenum steels, high alloy steels and austenitic steels.

It has long been a problem to produce a basic coated electrode which as a low hydrogen content and which will absorb water only at a slow rate and to a small extent. Such moisture resistance would ensure greater freedom from the welding effects which are associated with water present in the electrode coating.

The water content of an electrode coating is the source of the hydrogen imparted during the welding process to the weld metal and to adjust zones of the parent metal. If this hydrogen concentration is high, then the weld and/or the parent metal may develop cracks. It has been found that the maximum permissible moisture in the coating is 0.2% by weight of the coating if the weld is to be free from cracks. The water in the electrode coating is normally present as water of crystallization, or is in combination with the flux minerals, or is taken up by hygroscopic materials contained in the coating. Certain materials are unsuitable for use in the coatings which are to be applied to low hydrogen welding electrodes, on account of the water of crystallization which they contain *e.g.* mica. Other materials, such as alkali metal organic pressing agents, for example alkali metal alginates, such as sodium alginate, or sodium carboxymethylcellulose which are used to facilitate manufacture, may however, after heat treatment at baking temperatures normally associated with basic coated electrodes, produce very hygroscopic materials. It is frequently necessary to bake the coating at relatively high temperatures in order to remove the hydrocarbons and water contained in the binders and pressing agents. This temperature may be as high as 500°C. Although in practice temperatures within the range 350° C. to 450°C. are more commonly employed.

According to the present invention, there is provided a method of preparing a moisture resistant coated low hydrogen welding electrode, which method comprises applying to the surface of the electrode, a moisture resistant basic flux and subsequently subjecting the coated electrode to heat treatment at

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a temperature within the range 520°C. to 620°C, wherein there is incorporated in the moisture resistant basic flux 10% to 25% by weight on the weight of the flux of an alkali metal silicate solution binder having an alkali metal silicate content of from 35% to 45% by weight of the weight of the solution and a molecular ratio of silica to alkali metal oxide in the alkali metal silicate within the range 2.9:1 to 3.9:1.

It has been found that the moisture absorption resistance of the coating is improved by ensuring that the flux is substantially free from hygroscopic materials, such as residues of heat treated alkali metal organic pressing agents and other alkali metal compounds and materials which are hygroscopic, for example, alginates, potassium carbonates, sodium carbonate, potassium oxide, sodium oxide, and calcium oxide.

The binder may comprise sodium silicate or potassium silicate aqueous solution which may be used as sodium silicate or potassium silicate in the first instance, or may be a mixture of the two.

The lower temperature limit for the heat treatment is 520°C. and the maximum is 620°C., since above this temperature there is a loss of coating adhesion and a softening of the smaller diameter core wires.

It will be appreciated that the exact nature of the coating composition will depend on the material being welded. For instance, a flux suitable for an electrode to be used in the welding of mild steel would have the following composition:—

	Parts by weight
Limestone	15 to 45
Fluorspar	0 to 30
Rutile	40 to 0
*Ferro-manganese	10 to 2
*Ferro-silicon	10 to 0
*Ferro-titanium	0 to 10
Iron powder	50 to 0
Zircon	25 to 0
Clay	0 to 6
Organic Pressing Agent	4 to 0

(to give a total of 100 parts by weight)

*These ferro-alloys may be replaced in whole or part by ferro-manganese, silico manganese or other deoxidising agents. These constituents are thoroughly mixed. To 100 parts by weight of this powder, 10 to 25 parts by weight of alkali liquid binder are added in accordance with the invention and mixed to form a paste with which the electrode is then coated.

In a similar manner, a flux suitable for an electrode to be used in the welding of low alloy high tensile creep resisting steel or for the hard facing of steel, would have the following composition in parts by weight:—

	Parts
Limestone	25 to 37
Fluorspar	12 to 18
Rutile	0 to 38
*Ferro-manganese	0 to 50
*Ferro-silicon	5 to 7
*Ferro-titanium	2 to 15
Ferro-molybdenum	0 to 13
Nickel	0 to 10
Chromium metal	0 to 35
Ferro-chromium	0 to 25
Ferro-boron	0 to 4
Clay	3 to 8
Organic pressing Agent	0 to 2

(to give a total of 100 parts by weight)

*These ferro-alloys may be replaced in whole or in part by ferro-manganese, silico-manganese, or other deoxidising agents.

The quantity of alkali metal silicate solution binder required is from 10 to 25 parts by weight of binder to 100 parts of the above constituents. The resulting composition is mixed to form a paste and the electrode surface then coated as before.

For the welding of austenitic steel, a typical flux composition would be in parts by weight:—

	Parts
Limestone	16 to 30
Fluorspar	6 to 22
Ferro-niobium	0 to 8
Ferro-chromium	0 to 17
Chromium Metal	0 to 12
Ferro-molybdenum	1 to 12
Felspar	0 to 11
Rutile	0 to 40
Nickel	0 to 5
*Ferro-manganese	1 to 15
*Ferro-titanium	0 to 8
Clay	4 to 6
Organic pressing agent	0 to 2

(to give a total of 100 parts by weight)

*These ferro-alloys may be replaced in whole or in part by ferro-manganese, silico-manganese or other deoxidising agents.

The quantity of alkali liquid binder required is within the range 10 to 25 parts by weight to 100 parts of the above constituents.

Following is a description by way of example only of methods of carrying the invention into effect.

Example I

A flux composition suitable for coating an electrode to be employed in the welding of mild steel was prepared from the following constituents:—

	Parts by weight
Limestone	30
Fluorspar	26
Rutile	7
Ferro-manganese	6
Ferro-silicon	6
Iron powder	16
Clay	6

The alkali metal silicate solution binder containing from 35% to 45% by weight of sodium and/or potassium silicates and having a molecular ratio of silica to alkali metal oxide of 3.3 to 1.0 was added to the fluxing composition in a proportion of 22 parts by weight of solution to 100 parts by weight of the composition. The whole was thoroughly mixed and coated on to the electrode which was then heat treated at a temperature of 520°C.

The welding electrode coated with the composition described above was moisture resistant and was suitable for the welding of mild steel.

EXAMPLE II

A fluxing composition suitable for the coating of an electrode to be used in the welding of low alloy high tensile creep resisting steel was prepared having the following composition:—

	Parts by weight
Limestone	33
Fluorspar	16
Rutile	38
Ferro-manganese	4
Ferro-silicon	6
Ferro-titanium	4
Ferro-molybdenum	2
Chromium metal	2
Clay	4
Organic pressing agent	1

24 part by weight of an alkali metal silicate solution binder were added to 100 parts of the powder. The alkali metal silicate solution binder contained between 35 and 45% by weight of silicate; the molecular ratio of silica to alkali metal oxide was 2.9:1.

The composition was thoroughly mixed to form a paste and was subsequently coated on to the surface of the electrode. The coated electrode was then heat treated at a temperature of about 550°C.

This moisture resistant electrode was admirably suited for the welding of creep resisting steel.

EXAMPLE III

A fluxing composition was made up having the following composition in parts by weight:—

	Parts
Limestone	18
Fluorspar	7
Ferro-niobium	6
Ferro-chromium	11
Ferro-molybdenum	1½
Rutile	35
Nickel	2
Ferro-manganese	9
Clay	5

18 parts by weight of an alkali metal silicate solution binder were added to 100 parts by weight of the composition. The alkali metal silicate solution binder contained between 35% and 45% of sodium and/or potassium silicates and the molecular ratio of silica to alkali metal oxide was 3.0. The flux composition and binder were thoroughly mixed and coated on to the electrode which was then heat treated at a temperature of 520°C. The coated electrode was moisture resistant and was suitable for the welding of austenitic steel.

EXAMPLE IV

A flux coating for a welding electrode was prepared from a fluxing composition containing the following ingredients:—

	Parts by weight
Limestone	30
Fluorspar	20
Ferro-manganese	4
Ferro-silicon	6
Iron powder	25
Rutile	10
Clay	5

To the above composition was added an alkali metal silicate binder solution comprising a mixture of solutions of sodium silicate and potassium silicate of the following compositions (based on the above described fluxing composition):—

	Parts by weight
Sodium silicate solution	7½
Potassium silicate solution	15

The solutions of sodium silicate and potassium silicate each contained between 35% and 45% of sodium and potassium silicates, respectively, and the molecular ratio of silica to alkali metal oxide in each solution was about 3:1.

The flux composition and binder were thoroughly mixed prior to coating on the electrode. The coated electrode was then heat treated at a temperature of 520°C.

The rate of absorption of moisture of this coated electrode under conditions of high relative humidity is shown as curve A in the graph accompanying the provisional specification. On the same graph is represented by curves B,C, and D a range of moisture absorption rates normally found with basic coated low hydrogen electrodes.

As can be seen, the moisture resistant electrode tested under conditions of relatively high relative humidity, absorbs moisture at a rate considerably slower than the best of the conventional types. Furthermore, the moisture level of the electrode coated in accordance with the present invention remains below the permissible 0.2% maximum level for a much longer period.

WHAT WE CLAIM IS:—

1. A method of preparing a moisture resistant coated low hydrogen welding electrode, which method comprises applying to the sur-

face of the electrode a moisture resistant basic flux, and subsequently subjecting the coated electrode to heat treatment at a temperature within the range 520°C. to 620°C. wherein there is incorporated in the moisture resistant basic flux 10% to 25% by weight on the weight of the flux of an alkali metal silicate solution binder having an alkali metal silicate content of from 35% to 45% by weight of the weight of the solution and a molecular ratio of silica to alkali metal oxide in the alkali metal silicate within the range 2.9:1 to 3.9:1.

2. A method as claimed in claim 1 wherein the alkali metal silicate is sodium silicate or potassium silicate.

3. A method as claimed in claim 1 wherein the binder comprises a mixture of sodium silicate and potassium silicate.

4. A method as claimed in any preceding claim wherein the flux is substantially free from hygroscopic materials.

5. A method as claimed in any preceding claim wherein the flux has the following composition:—

	Parts by weight
Limestone	15 to 45
Fluorspar	0 to 30
Rutile	40 to 0
Ferro-manganese	10 to 2
Ferro-silicon	10 to 0
Ferro-titanium	0 to 10
Iron powder	50 to 0
Zircon	25 to 0
Clay	0 to 6
Organic Pressing Agent	4 to 0

giving a total of 100 parts by weight, and 10 to 25 parts by weight of alkali metal silicate solution binder.

6. A method as claimed in any one of claims 1 to 4 wherein the flux has the composition in parts by weight:

	Parts
Limestone	25 to 37
Fluorspar	12 to 18
Rutile	0 to 38
Ferro-manganese	0 to 50
Ferro-silicon	5 to 7
Ferro-titanium	2 to 15
Ferro-molybdenum	0 to 13
Nickel	0 to 10
Chromium metal	0 to 35
Ferro-chromium	0 to 25
Ferro-boron	0 to 4
Clay	3 to 8
Organic pressing Agent	0 to 2

giving a total of 100 parts by weight and 10 to 25 parts by weight of alkali metal silicate solution binder.

7. A method as claimed in any one of claims 1 to 4 wherein the flux has the composition in parts by weight:

	Parts
Limestone	16 to 30
Fluorspar	6 to 22
Ferro-niobium	0 to 8
Ferro-chromium	0 to 17
Chromium Metal	0 to 12
Ferro-molybdenum	1 to 12
Felspar	0 to 11
Rutile	0 to 40
Nickel	0 to 5
Ferro-manganese	1 to 19
Ferro-titanium	0 to 8
Clay	4 to 6
Organic pressing agent	0 to 2

giving a total of 100 parts by weight of 10 to 25 parts by weight of a alkali metal silicate solution binder.

8. A method as claimed in any one of claims 5, 6, and 7 wherein any one or more of the ferro-alloys are replaced in whole or part by ferro-manganese, silico-manganese or other deoxidising agents.

9. A method as claimed in claim 1 substantially as hereinbefore described with reference to any one of the specific Examples.

10. A moisture resistant coated low hydrogen welding electrode when prepared by the method claimed in any preceding claim.

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1,038,977 PROVISIONAL SPECIFICATION

I SHEET

This drawing is a reproduction of the Original on a reduced scale.